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星状神经节阻滞对心肌保护的研究进展及现状

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摘 要

星状神经节阻滞(Stellate ganglion block, SGB)是一种具有治疗性的神经阻滞，主要用于缓解一些局部或颈部疼痛等症状。过去几年，越来越多的数据表明SGB还具有脏器保护作用，并在心脏、肺脏、微循环等方面有积极影响。目前有关研究SGB保护心肌的研究相对较少，并且研究结果不同。目前认为不同侧SGB对心血管系统作用存在影响差别，这可能与解剖结构存在一定差异及节后神经纤维支配区域存在差异有关，但是还需要进一步研究和探究其作用机制。

关键词

心肌，保护，星状神经节阻滞

Research Progress and Current Status of Myocardial Protection by Stellate Ganglion Block

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Abstract

Stellate ganglion block (SGB) is a therapeutic nerve block used to relieve some symptoms such as local or neck pain. Over the past few years, more and more data have shown that SGB also has an organ protective effect and has a positive impact on the heart, lungs, microcirculation, and more. At present, there are relatively few studies on the protection of myocardium by SGB, and the research results are different. At present, it is believed that different sides of SGB have different effects on the cardiovascular system, which may be related to differences in anatomical structure and differences in postganglionic nerve fiber innervation region, but further research and exploration of its mechanism are needed.

Keywords

Myocardial, Protection, Stellate Ganglion Block

1. 引言

冠状动脉的血流量以及其携氧能力决定心肌氧供。当心肌增加对氧耗的需求时，为了满足心肌自身的需要，必须通过冠状动脉增加血流来实现。围手术期会触发一种应激反应，导致交感神经系统过度活跃，打破心肌氧供和氧需原有的平衡，致使心肌疲劳损伤，临床症状为心肌缺血和心肌梗死的表现[1]。此外，围手术期心肌损伤的另一个重要因素是血流动力学剧烈波动[2] [3]。虽然在非心脏手术患者中围手术期心肌损害容易出现，但常常因没有明显临床症状而被忽视。研究表明，通过对交感区域的活动进行阻断可以通过扩张冠状动脉改善血流动力学，增加心脏供氧量，缓解心绞痛和心肌缺血，并对心肌产生保护效果[4] [5]。因此，在围手术期中，SGB 可能会提供心脏保护效果。

星状神经节(SG)是位于颈部和胸部的神经节，约有 80%的人都存在。SG 包含颈下神经节和第 1 胸神经节，或者有颈中神经节和第 2 胸神经节参与组成[6]。SG 通过灰色交通支(C3~7)与 C8 和 T1 神经相连，分布于血管、腺体等部位。SGB 是一种交感神经阻滞方法，最早被报道是在 20 世纪 70 年代，属于微创治疗，常被用于门诊疼痛治疗[7]。超声引导下行 SGB 可以减少动脉内注射和软组织损伤等并发症，提高了 SGB 的安全性[8]。

2. 在全身麻醉气管插管应激反应中 SGB 对心肌保护作用

在全身麻醉气管插管应激反应中 SGB 对心肌保护作用得到了研究。在全身麻醉诱导过程中，喉镜检查和气管导管机械性刺激会导致交感肾上腺过度亢进，从而引发心脑血管应激反应[9]。这种反应在喉镜检查开始的 30~45 秒内达到高峰，然后逐渐消退[10]。老年患者由于器官储备功能下降、反应能力差，及其对于心血管系统的敏感性增加，会使得血流动力学波动大，增加意外风险[11]。虽然几种方法可以用来减少这样的反应，但是这些方法的治疗并不能达到临床满意效果[12] [13]。

Koyama 等人的研究表明，右侧 SGB 不影响血压，仅抑制心脏交感神经兴奋[14]。由于心肺压力感受器引起的心脏交感神经兴奋性也能够 SGB 的抑制。Hiroshi 等人的研究提示，对于气管插管与手术操

作过程中的应激反应 SGB 可以有效抑制，能维持血流动力学效应的稳定[15]。Chen 等研究表明，与基线和 SGB 组相比，对照组的速率压力乘积值显著升高。对照组低频功率(LF)、LF/高频功率(HF)较基线值明显升高，HF 及 HF 归一化单位明显降低。与对照组相比，SGB 组的 LF、LF 归一化单位、LF/HF 明显降低，其结果表示 SGB 可以使交感肾上腺的亢进受到抑制，减轻了老年患者在全麻诱导和气管插管时的血流动力学波动，从而使心肌缺血的风险降低[16]。总之，在全身麻醉气管插管应激反应中 SGB 对心肌保护作用的应用具有较好的临床意义和前景。

3. 在腹腔镜手术中 SGB 对心肌保护作用

随着微创外科技术的广泛应用，腹腔镜手术已成为一种常见的治疗方法。在该手术中，将二氧化碳注入腹腔以形成气腹，但是气腹和导致高碳酸血症都会刺激交感神经，从而导致肾素－血管紧张素－醛固酮系统释放血管加压素，进而引起血流动力学剧烈波动[17]。这些变化会导致心率、平均动脉血压、心输出量和全身性血管阻力增加，从而可能引起高血压、心动过速、心动过缓等不良反应[18]。为了对抗这些血管升压反应，许多药物和方法被用来控制血压和心律失常，其中包括阿片类药物、$\alpha 2$ 受体激动剂、β 受体阻滞剂和局部麻醉药[19] [20]。

近年来，SGB 也被应用于腹腔镜手术。SGB 能够减轻平均动脉压、心率波动，使患者血流动力学维持相对稳定，从而有利于应激反应的减轻[21] [22]。同时，研究表明 SGB 可以通过影响血管内皮素-1 (Endothefin、ET-1)与内皮一氧化氮合酶(Nitric oxide synthase, NOS)进而达到降压作用[23] [24]。在另一项研究中，SGB 可通过上调迷走神经紧张性，起到对 CO_2 气腹引起交感神经兴奋的抑制作用[25]。

因此，在腹腔镜手术中应用 SGB 可以减轻二氧化碳人工气腹对患者的应激反应，并且能有效抑制血压升高和心律失常发生，同时也能够减轻 CO_2 气腹对心血管的反应和降低心肌氧耗量，起到心肌保护作用[26]。

4. 在冠状动脉搭桥术中 SGB 对心肌保护作用

随着移植物在冠脉搭桥手术中更频繁地使用。但桡动脉的血管收缩倾向和血管结构目前仍然是手术后早期面临的主要问题[27] [28]。患者术中及预后的好坏取决于桡动脉痉挛严重程度。为解决这一问题，SGB 被用于其临床治疗。SGB 主要优点是舒张动脉血管、增加血流量以及减少上肢疼痛[29]。最新研究显示，在冠状动脉搭桥术前预行 SGB 可防止桡动脉移植物血管痉挛的作用，也可降低术中房颤发生率和 ST 段抬高的发生率、同时减少正性肌力药物的消耗量，对心肌起到保护作用[30]。同时，SGB 还可以对体外循环后大多数患者出现高血压的中收缩压安全地降低，从而减少了术后出血、脑血管意外和升高心肌氧需求量的风险[31]。SGB 的这一作用机制可能与交感神经受到阻滞导致冠状动脉舒张相关[32]。综上，SGB 在冠状动脉搭桥术中的作用已经被研究证实。

5. 心胸外科手术后 SGB 在心房颤动预防中的应用

术后心房颤动(Postoperative atrial fibrillation, POAF)是心脏手术后最常见的合并症之一，该病使患者的发病率、死亡率、住院时间和住院费用相应增加[33]。在多项研究中显示[34] [35] [36]，心房颤动在心脏直视手术中的发生率非常高，并且会进一步恶化患者的血流动力学状况，增加充血性心力衰竭、缺血性卒中以及死亡风险等相关并发症的发生率，并增加重症监护病房的需要时间以及额外的医疗资源[37]。

尽管已制定了预防指南和实施措施来处理此类并发症，但是在手术后这种变化仍然存在[38]。SGB 技术能够优化心房颤动的诱发，并且 SG 切除能减少或预防 POAF 的发作[39] [40] [41]。现有数据显示，在冠状动脉旁路移植术(Coronary artery bypass grafting, CABG)患者中实施 SGB，POAF 发生率为 18.2%，

要比以往 CABG 术后发生心房颤动比率高达 30%~45%低得多[42] [43]。

虽然对于围手术期 SGB 技术在减轻或预防 POAF 的发作方面已有一些研究成果[44] [45]，但是在心胸外科手术中这项技术的相关临床研究仍然存在不足。此外，还需要设计更多的临床随机对照试验来明确围手术期 SGB 技术是否能够对心胸外科手术患者减轻或预防 POAF 的发作具有积极影响。

6. 在顽固性室性心律失常治疗中 SGB 的应用

室性心律失常(Ventricular arrhythmias, VA)是一类常见并存在致命风险的急性危重临床事件，然而，电风暴(Electrical storm, ES)是室性心动过速(Ventricular tachycardia)或室颤(Ventricular fibrillation, VF)聚急性发作的一种，会增加心源性猝死的发生率[46]。其中抗心律失常药物、机械性的血流动力学支持为传统的治疗方法，但很难治愈。对于单形性 VT 和室性期前收缩触发的多形性 VT 可以行射频消融，但某些危重患者可能不存在采用这种方法的机会[47]。

自主神经系统对室性心律失常的触发和维持有影响，采用抑制交感神经系统的活动可控制室性心律失常。经过外科交感神经切除使左侧心交感神经离断可减轻室性心律失常的负担[48]，但在电风暴等特殊情况下不适用。颈部交感神经节阻滞术是一种新兴的快速、安全、有效的微创治疗技术，通过暂时的交感神经阻断来治疗 VT 或 VF [47] [49]。多项研究表明，使用 SGB 不仅可以使心脏交感神经张力降低，还可对室性心律失常的负担进行短期控制并减少对内部或外部除颤的需求[50] [51] [52]。经皮超声引导下 SGB 创伤小、操作方便，可以成为对难治性室性心动过速危重患者床旁应用的可能方案。

综上所述，SGB 对于心脏功能确实有益且安全。然而，由于不同人的解剖结构存在差异，不同侧阻滞的影响也不尽相同，因此需要更多的临床试验进行全面研究。

此外，目前尚不清楚 SGB 所需药物种类、剂量、浓度以及作用持续时间，因此其是否可以广泛应用于临床作为一种心肌保护措施仍需进一步的临床研究。总的来说，虽然 SGB 具有一定的优势，但还需要深入地研究和探讨。

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参考文献

[1] Ardehali, A. and Ports, T.A. (1990) Myocardial Oxygen Supply and Demand. *Chest*, **98**, 699-705. https://doi.org/10.1378/chest.98.3.699

[2] Flu, W.J., Schouten, O., van Kuijk, J.P., *et al*. (2010) Perioperative Cardiac Damage Invascular Surgery Patients. *European Journal of Vascular and Endovascular Surgery*, **40**, 1-8. https://doi.org/10.1016/j.ejvs.2010.03.014

[3] Sessler, D.I. and Khanna, A.K. (2018) Perioperative Myocardial Injury and the Contribution of Hypotension. *Intensive Care Medicine*, **44**, 811-822. https://doi.org/10.1007/s00134-018-5224-7

[4] 黄倩, 张炳东, 王玲. 右侧星状神经阻滞对大鼠体外循环微循环的影响[J]. 中国临床新医学, 2014, 7(5): 390-393.

[5] 王薇, 王焰斌, 石双平, 等. 超声引导下星状神经节阻滞对心脏瓣膜置换术患者的心肌保护作用[J]. 山西医药杂志, 2018, 47(22): 2682-2685.

[6] Narouze, S. (2014) Ultrasound-Guided Stellate Ganglion Block: Safety and Efficacy. *Current Pain and Headache Reports*, **18**, Article No. 424. https://doi.org/10.1007/s11916-014-0424-5

[7] Aggarwal, A., Suresh, V., Gupta, B. and Sonthalia, S. (2020) Post-Herpetic Neuralgia: A Systematic Review of Current Interventional Pain Management Strategies. *Journal of Cutaneous and Aesthetic Surgery*, **13**, 265-274.

[8] Goel, V., Patwardhan, A.M., Ibrahim, M., Howe, C.L., Schultz, D.M. and Shankar, H. (2019) Complications Associated with Stellate Ganglion Nerve Block: A Systematic Review. *Regional Anesthesia & Pain Medicine*, **42**, 741-750.

[9] El-Shmaa, N.S. (2020) Evaluation of King's Vision Videolaryngoscope and Glidescope on Hemodynamic Stress Response to Laryngoscopy and Endotracheal Intubation. *Journal of Anaesthesiology Clinical Pharmacology*, **36**, 233-237.

https://doi.org/10.4103/joacp.JOACP_183_18

[10] Zhuang, X.L., Zeng, Y.M. and Chen, B.L. (2003) Chapter 5. Modern Anesthesiology. In: *Anesthesiology and Circulation*, 3rd Edition, People's Medical Publishing House, Beijing, 481.

[11] Russell, D.W., Casey, J.D., Gibbs, K.W., *et al*. (2022) Effect of Fluid Bolus Administration on Cardiovascular Collapse among Critically Ill Patients Undergoing Tracheal Intubation: A Randomized Clinical Trial. *JAMA*, **328**, 270-279. https://doi.org/10.1001/jama.2022.9792

[12] Singh, S., Laing, E.F., Owiredu, W.K. and Singh, A. (2013) Comparison of Esmolol and Lidocaine for Attenuation of Cardiovascular Stress Response to Laryngoscopy and Endotracheal Intubation in a Ghanaian Population. *Anesthesia Essays and Researches*, **7**, 83-88. https://doi.org/10.4103/0259-1162.114008

[13] El-Shmaa, N.S. and El-Baradey, G.F. (2016) The Efficacy of Labetalol vs Dexmedetomidine for Attenuation of Hemodynamic Stress Response to Laryngoscopy and Endotracheal Intubation. *Journal of Clinical Anesthesia*, **31**, 267-273. https://doi.org/10.1016/j.jclinane.2016.01.037

[14] Koyama, S., Sato, N., Nagashima, K., *et al*. (2002) Effects of Right Stellate Ganglion Block on the Autonomic Nervous Function of the Heart: A Study Using the Head-Up Tilt Test. *Circulation Journal*, **66**, 645-648. https://doi.org/10.1253/circj.66.645

[15] Hiroshi, I., Syoraku, S. and Kazuhiro, W. (2002) The Role of Cervical Sympathetic Nervous System in Secretions of Stress or Pineal Hormone A Hypothesis. *The Pain Clinic*, **13**, 233-244. https://doi.org/10.1163/156856901753702401

[16] Chen, Y.Q., Jin, X.J., Liu, Z.F., *et al*. (2015) Effects of Stellate Ganglion Block on Cardiovascular Reaction and Heart Rate Variability in Elderly Patients during Anesthesia Induction and Endotracheal Intubation. *Journal of Clinical Anesthesia*, **27**, 140-145. https://doi.org/10.1016/j.jclinane.2014.06.012

[17] Gayathri, L., Kuppusamy, A., Mirunalini, G. and Mani, K. (2023) A Comparison between the Effects of Single-Dose Oral Gabapentin and Oral Clonidine on Hemodynamic Parameters in Laparoscopic Surgeries: A Randomized Controlled Trial. *Cureus*, **15**, e37251. https://doi.org/10.7759/cureus.37251

[18] Mutetwa, E.N., Shumbairerwa, S., Crawford, A., *et al*. (2015) Metabolic Effects of Carbon Dioxide (CO_2) Insufflation during Laparoscopic Surgery: Changes in pH, Arterial Partial Pressure of Carbon Dioxide ($PaCo_2$) and End Tidal Carbon Dioxide ($EtCO_2$). *Central African Journal of Medicine*, **61**, 61-65.

[19] Richman, J.M., Liu, S.S., Courpas, G., *et al*. (2006) Does Continuous Peripheral Nerve Block Provide Superior Pain Control to Opioids A Meta-Analysis. *Anesthesia & Analgesia*, **102**: 248-257. https://doi.org/10.1213/01.ANE.0000181289.09675.7D

[20] Ram, C.V. (2010) Beta-Blockers in Hypertension. *American Journal of Cardiology*, **106**, 1819-1825. https://doi.org/10.1016/j.amjcard.2010.08.023

[21] 张亚莉. 星状神经节阻滞对腹腔镜胆囊切除术患者血流动力学、神经内分泌功能的影响[J]. 临床医学, 2021, 41(5): 80-82. https://doi.org/10.19528/j.issn.1003-3548.2021.05.032

[22] Chen, Y.Q., Xie, Y.Y., Wang, B. and Jin, X.J. (2017) Effect of Stellate Ganglion Block on Hemodynamics and Stress Responses during CO_2-Pneumoperitoneum in Elderly Patients. *Journal of Clinical Anesthesia*, **37**, 149-153. https://doi.org/10.1016/j.jclinane.2016.12.003

[23] 侯霄雷, 李白翎, 赵雷, 等. 血府逐瘀胶囊对急性心肌梗死再灌注后心肌及内皮素-1、一氧化氮/一氧化氮合酶体系影响的实验研究[J]. 中西医结合学报, 2008, 6(4): 381-386.

[24] 陈永权, 胡光祥, 付群, 等. 星状神经节阻滞对自发性高血压大鼠血压的影响[J]. 浙江大学学报医学版, 2012, 41(1): 65-68.

[25] 谢雨逸孜, 陈永权. 右侧星状神经节阻滞对 CO_2 气腹患者心率变异性的影响[J]. 中华麻醉学杂志, 2012(7): 833-835.

[26] 童金亮. 星状神经节阻滞对腹腔镜胆囊切除术中人工气腹患者应激反应的影响[J]. 国际医药卫生导报, 2017, 23(23): 3714-3716.

[27] He, G.W. and Taggart, D.P. (2016) Antispastic Management in Arterial Grafts in Coronary Artery Bypass Grafting Surgery. *The Annals of Thoracic Surgery*, **102**, 659-668. https://doi.org/10.1016/j.athoracsur.2016.03.017

[28] Hamilton, G.W., Dinh, D., Yeoh, J., *et al*. (2023) Characteristics of Radial Artery Coronary Bypass Graft Failure and Outcomes Following Subsequent Percutaneous Coronary Intervention. *JACC*: *Cardiovascular Interventions*, **16**, 457-467. https://doi.org/10.1016/j.jcin.2022.11.035

[29] Feigin, G., Velasco Figueroa, S., Englesakis, M.F., D'Souza, R., Hoydonckx, Y. and Bhatia, A. (2023) Stellate Ganglion Block for Non-Pain Indications: A Scoping Review. *Pain Medicine*, **24**, 775-781. https://doi.org/10.1093/pm/pnad011

[30] Yildirim, V., Akay, H.T., Bingol, H., *et al*. (2007) Pre-Emptive Stellate Ganglion Block Increases the Patency of Radi-

al Artery Grafts in Coronary Artery Bypass Surgery. *Acta Anaesthesiologica Scandinavica*, **51**, 434-440. https://doi.org/10.1111/j.1399-6576.2006.01260.x

[31] Garneau, S.Y., Deschamps, A., Couture, P., *et al*. (2011) Preliminary Experience in the Use of Preoperative Echo-Guided Left Stellate Ganglion Block in Patients Undergoing Cardiac Surgery. *Journal of Cardiothoracic and Vascular Anesthesia*, **25**, 78-84. https://doi.org/10.1053/j.jvca.2010.03.007

[32] Hu, X.Q., Zheng, X.Y., Ma, W.X. and Jiang, X. (2020) Efficacy of Stellate Ganglion Block in Perioperative Period of Patients with Chronic Sinusitis and Hypertension. *Chinese Medical Journal*, **100**, 2591-2595. (In Chinese)

[33] LaPar, D.J., Speir, A.M., Crosby, I.K., *et al*. (2014) Postoperative Atrial Fibrillation Significantly Increases Mortality, Hospital Readmission, and Hospital Costs. *The Annals of Thoracic Surgery*, **98**, 527-533. https://doi.org/10.1016/j.athoracsur.2014.03.039

[34] Engin, M., Ozsin, K.K., Savran, M., Guvenc, O., Yavuz, S. and Ozyazicioglu, A.F. (2021) Visceral Adiposity Index and Prognostic Nutritional Index in Predicting Atrial Fibrillation after On-Pump Coronary Artery Bypass Operations: A Prospective Study. *Brazilian Journal of Cardiovascular Surgery*, **36**, 522-529. https://doi.org/10.21470/1678-9741-2020-0044

[35] Yang, H., Yuan, C., Yang, J., Xiang, H., Lan, W. and Tang, Y. (2022) A Novel Predictive Model for New-Onset Atrial Fibrillation in Patients after Isolated Cardiac Valve Surgery. *Frontiers in Cardiovascular Medicine*, **9**, Article ID: 949259. https://doi.org/10.3389/fcvm.2022.949259

[36] Gong, J., Wei, Y., Zhang, Q., Tang, J. and Chang, Q. (2022) Nomogram Predicts Atrial Fibrillation after Coronary Artery Bypass Grafting. *BMC Cardiovascular Disorders*, **22**, Article No. 388. https://doi.org/10.1186/s12872-022-02824-1

[37] Hernández-Leiva, E., Alvarado, P. and Dennis, R.J. (2019) Postoperative Atrial Fibrillation: Evaluation of Its Economic Impact on the Costs of Cardiac Surgery. *Brazilian Journal of Cardiovascular Surgery*, **34**, 179-186. https://doi.org/10.21470/1678-9741-2018-0218

[38] Muehlschlegel, J.D., Burrage, P.S., Ngai, J.Y., *et al*. (2019) Society of Cardiovascular Anesthesiologists/European Association of Cardiothoracic Anaesthetists Practice Advisory for the Management of Perioperative Atrial Fibrillation in Patients Undergoing Cardiac Surgery. *Anesthesia & Analgesia*, **128**, 33-42. https://doi.org/10.1213/ANE.0000000000003865

[39] Al-Atassi, T., Toeg, H., Malas, T., *et al*. (2014) Mapping and Ablation of Autonomic Ganglia in Prevention of Postoperative Atrial Fibrillation in Coronary Surgery: MAAPPAFS Atrial Fibrillation Randomized Controlled Pilot Study. *Canadian Journal of Cardiology*, **30**, 1202-1207. https://doi.org/10.1016/j.cjca.2014.04.018

[40] Zafeiropoulos, S., Doundoulakis, I., Farmakis, I.T., *et al*. (2022) Autonomic Neuromodulation for Atrial Fibrillation Following Cardiac Surgery: JACC Review Topic of the Week. *Journal of the American College of Cardiology*, **79**, 682-694. https://doi.org/10.1016/j.jacc.2021.12.010

[41] Hanna, P., Buch, E., Stavrakis, S., *et al*. (2021) Neuroscientific Therapies for Atrial Fibrillation. *Cardiovascular Research*, **117**, 1732-1745. https://doi.org/10.1093/cvr/cvab172

[42] Connors, C.W., Craig, W.Y., Buchanan, S.A., *et al*. (2018) Efficacy and Efficiency of Perioperative Stellate Ganglion Blocks in Cardiac Surgery: A Pilot Study. *Journal of Cardiothoracic and Vascular Anesthesia*, **32**, e28-e30. https://doi.org/10.1053/j.jvca.2017.10.025

[43] Zheng, H., Xue, S., Hu, Z.L., Shan, J.G. and Yang, W.G. (2014) The Use of Statins to Prevent Postoperative Atrial Fibrillation after Coronary Artery Bypass Grafting: A Meta-Analysis of 12 Studies. *Journal of Cardiovascular Pharmacology*, **64**, 285-292. https://doi.org/10.1097/FJC.0000000000000102

[44] Leftheriotis, D., Flevari, P., Kossyvakis, C., *et al*. (2016) Acute Effects of Unilateral Temporary Stellate Ganglion Block on Human Atrial Electrophysiological Properties and Atrial Fibrillation Inducibility. *Heart Rhythm*, **13**, 2111-2117. https://doi.org/10.1016/j.hrthm.2016.06.025

[45] Ouyang, R., Li, X., Wang, R., Zhou, Q., Sun, Y. and Lei, E. (2020) Efeito do bloqueio do gânglio estrelado direito guiado por ultrassom na fibrilação atrial perioperatória em pacientes submetidos a lobectomia pulmonar: Estudo controlado randomizado [Effect of Ultrasound-Guided Right Stellate Ganglion Block on Perioperative Atrial Fibrillation in Patients Undergoing Lung Lobectomy: A Randomized Controlled Trial]. *Brazilian Journal of Anesthesiology*, **70**, 256-261. https://doi.org/10.1016/j.bjan.2020.03.007

[46] Jentzer, J.C., Noseworthy, P.A., Kashou, A.H., *et al*. (2023) Multidisciplinary Critical Care Management of Electrical Storm: JACC State-of-the-Art Review. *Journal of the American College of Cardiology*, **81**, 2189-2206. https://doi.org/10.1016/j.jacc.2023.03.424

[47] Fudim, M., Boortz-Marx, R., Ganesh, A., *et al*. (2017) Stellate Ganglion Blockade for the Treatment of Refractory Ventricular Arrhythmias: A Systematic Review and Meta-Analysis. *Journal of Cardiovascular Electrophysiology*, **28**, 1460-1467. https://doi.org/10.1111/jce.13324

[48] Vaseghi, M., Gima, J., Kanaan, C., *et al*. (2014) Cardiac Sympathetic Denervation in Patients with Refractory Ventricular Arrhythmias or Electrical Storm: Intermediate and Long-Term Follow-Up. *Heart Rhythm*, **11**, 360-366. https://doi.org/10.1016/j.hrthm.2013.11.028

[49] Savastano, S., Dusi, V., Baldi, E., *et al*. (2021) Anatomical-Based Percutaneous Left Stellate Ganglion Block in Patients with Drug-Refractory Electrical Storm and Structural Heart Disease: A Single-Centre Case Series. *Europace*, **23**, 581-586. https://doi.org/10.1093/europace/euaa319

[50] Reinertsen, E., Sabayon, M., Riso, M., Lloyd, M. and Spektor, B. (2021) Stellate Ganglion Blockade for Treating Refractory Electrical Storm: A Historical Cohort Study. *Canadian Journal of Anesthesia*, **68**, 1683-1689. https://doi.org/10.1007/s12630-021-02068-1

[51] Patel, R.A., Condrey, J.M., George, R.M., Wolf, B.J. and Wilson, S.H. (2023) Stellate Ganglion Block Catheters for Refractory Electrical Storm: A Retrospective Cohort and Care Pathway. *Regional Anesthesia & Pain Medicine*, **48**, 224-228. https://doi.org/10.1136/rapm-2022-104172

[52] Savastano, S., Baldi, E., Camporotondo, R., Belliato, M., Marinoni, B. and De Ferrari, G.M. (2020) Percutaneous Stellate Ganglion Block and Extracorporeal Cardiopulmonary Resuscitation: An Effective and Safe Combination for Refractory Ventricular Fibrillation. *Europace*, **22**, 148. https://doi.org/10.1093/europace/euz180